vStart 100 and 200 Hyper-V Reference Architecture

Release 1.3 for Dell 12th generation servers

Dell Global Solutions Engineering

Revision: A00

March 2012

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March 2012| Rev A00

Contents

1 Introduction 1
2 Audience 1
3 Solution Overview 2
3.1 Product Overview 4
3.1.1 PowerEdge R720 for Hyper-V Cluster 4
3.1.2 EqualLogic PS6100 for iSCSI Storage 4
3.1.3 PowerEdge R620 Management Server 5
3.1.4 PowerConnect 7048 or 6248 for LAN and SAN Traffic 5
4 Design Principles 7
4.1 No Single Point of Failure 7
4.2 Physical Separation of LAN and iSCSI SAN Traffic 7
4.3 Logical Separation of multiple LAN traffic types 7
4.4 Prerequisites and Datacenter Planning 7
5 Architecture 8
5.1 Network Architecture Overview 8
5.2 LAN Architecture 10
5.2.1 Traffic Isolation using VLANs 10
5.3 SAN Architecture 11
5.3.1 Traffic Isolation using VLAN 11
5.3.2 EqualLogic Storage Concepts 11
5.3.3 Volume Size Considerations 11
5.3.4 Storage Array RAID Considerations 12
5.4 Hyper-V Role and Failover Clustering Design 13
5.4.1 Roles and Features 13
5.5 Management Architecture 13
5.5.1 Management on the LAN 13
6 Scalability 16
6.1 Adding new servers to the Hyper-V Cluster 16
6.2 Adding new storage to the EqualLogic group 16
7 References 17

Tables

Table 1. Component Logical Groups 4
Table 2. Traffic Type Summary 10

Figures

Figure 1. vStart 100 Overview 2
Figure 2. vStart 200 Overview 3
Figure 3. vStart 100 and 200 Component Overview 6
Figure 4. vStart 200 Network Topology (Logical View) 9
Figure 5. EqualLogic Organizational Concepts 11
Figure 6. Management Overview (LAN) 15

1 Introduction

The vStart solution is a virtualization infrastructure solution that has been designed and validated by Dell Engineering. It is delivered racked, cabled, and ready to be integrated into your datacenter. vStart is offered as three configurations: vStart 50[1], 100 and 200.

The configurations include Dell™ PowerEdge™ R720 servers running Microsoft® Windows Server® 2008 R2 SP1 Datacenter Edition with Hyper-V® Role enabled, Dell EqualLogic™ PS6100 Series iSCSI storage, Dell PowerConnect™ 7048 or 6248 switches, a Dell PowerEdge R620 server that manages the solution by hosting Dell management tools and optional System Center Virtual Machine Manager 2008 R2.

The configurations also include Dell EqualLogic Host Integration Tools for Microsoft (HIT Kit) for Windows Server 2008 R2. The two vStart configurations vary in the number of R720 servers and EqualLogic PS6100 storage arrays to meet resource needs.

The following documents are provided to describe the various aspects of the solution. Contact your Dell Sales or Services representative to get the latest revision of all the documents.

- *vStart 100 and vStart 200 Hyper-V Reference Architecture (this document)* – Provides a reference overview, including various components, and how the solution is delivered.
- *vStart 100 and vStart 200 Hyper-V Solution Overview* – Provides a solution overview, including various components, and how it is delivered.
- *vStart 100 and vStart 200 Hyper-V Solution Specification* – Provides a detailed specification of various components included in the solution.
- *vStart 100 and vStart 200 Hyper-V Solution Design Guide* – Provides a detailed architectural solution design.

2 Audience

This document provides an overview of the vStart solution. Customers, including CTOs and IT managers, can use this document to understand the overview and scope of the solution.

IT administrators and managers can use this document to understand the solution architecture.

[1] vStart 50 is covered by a separate set of documents.

3 Solution Overview

The solution discussed in this whitepaper is powered by Dell PowerEdge servers, Dell EqualLogic iSCSI storage, Dell PowerConnect networking, and Microsoft Windows Server 2008 R2 with SP1. The solution implements Dell and Microsoft best practices, and EqualLogic SAN HeadQuarters (SAN HQ) and Group Manager are included in the solution for storage array monitoring and management. The solution also includes the rack, power distribution units (PDU), and an optional uninterruptible power supply (UPS), KMM (Keyboard, Monitor, Mouse), and management server.

The solution is offered in two main configurations, vStart 100 and 200. The variations between the two configurations are the number of PowerEdge R720 servers in the Hyper-V cluster and the number of EqualLogic storage arrays. vStart 100 includes three PowerEdge R720 servers and one EqualLogic storage array. vStart 200 includes six PowerEdge R720 servers and two EqualLogic storage arrays. An additional optional storage array can be added to both configurations and the resulting configuration will be referred to as vStart 100+ or vStart 200+ in the remainder of this document. Figure 1 and Figure 2 below provide a high-level overview of the components utilized in each of the configurations.

Figure 1. vStart 100 Overview

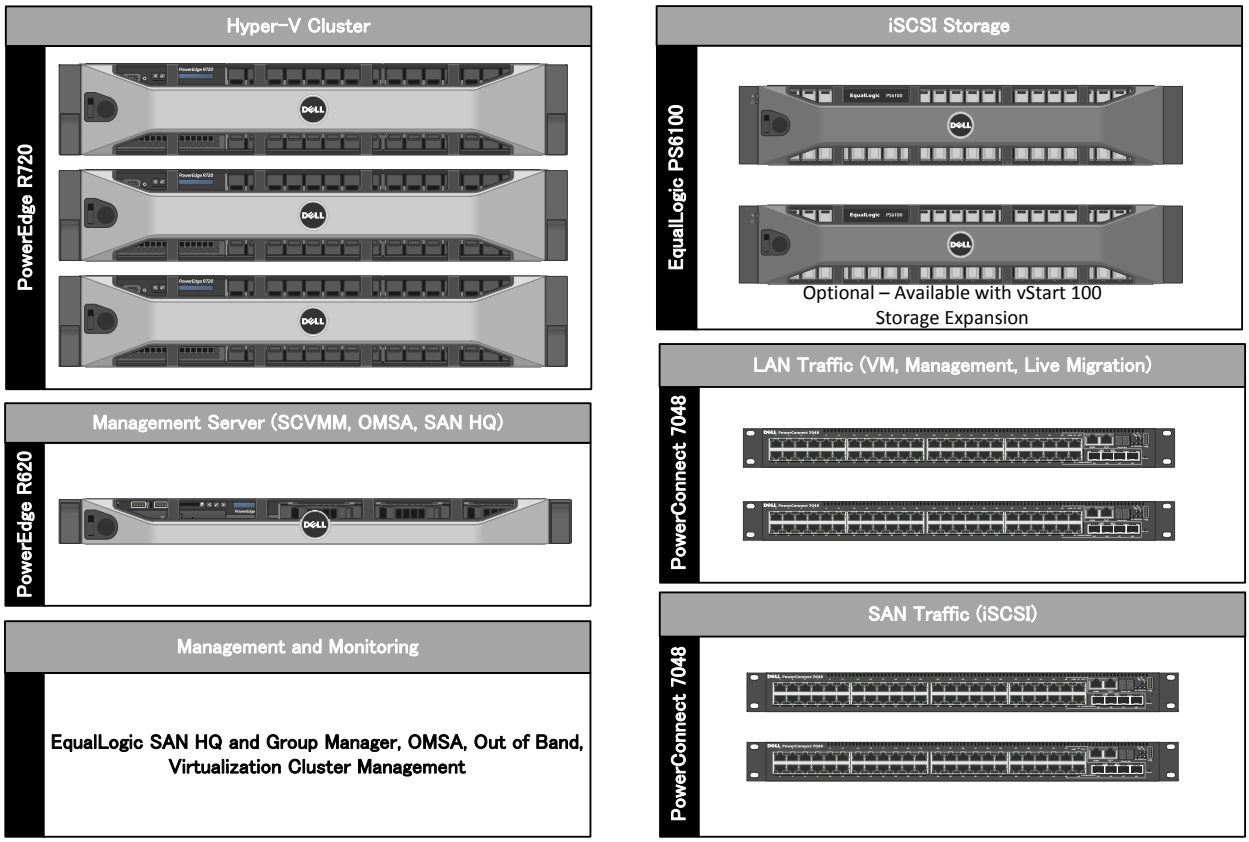


Figure 2. vStart 200 Overview

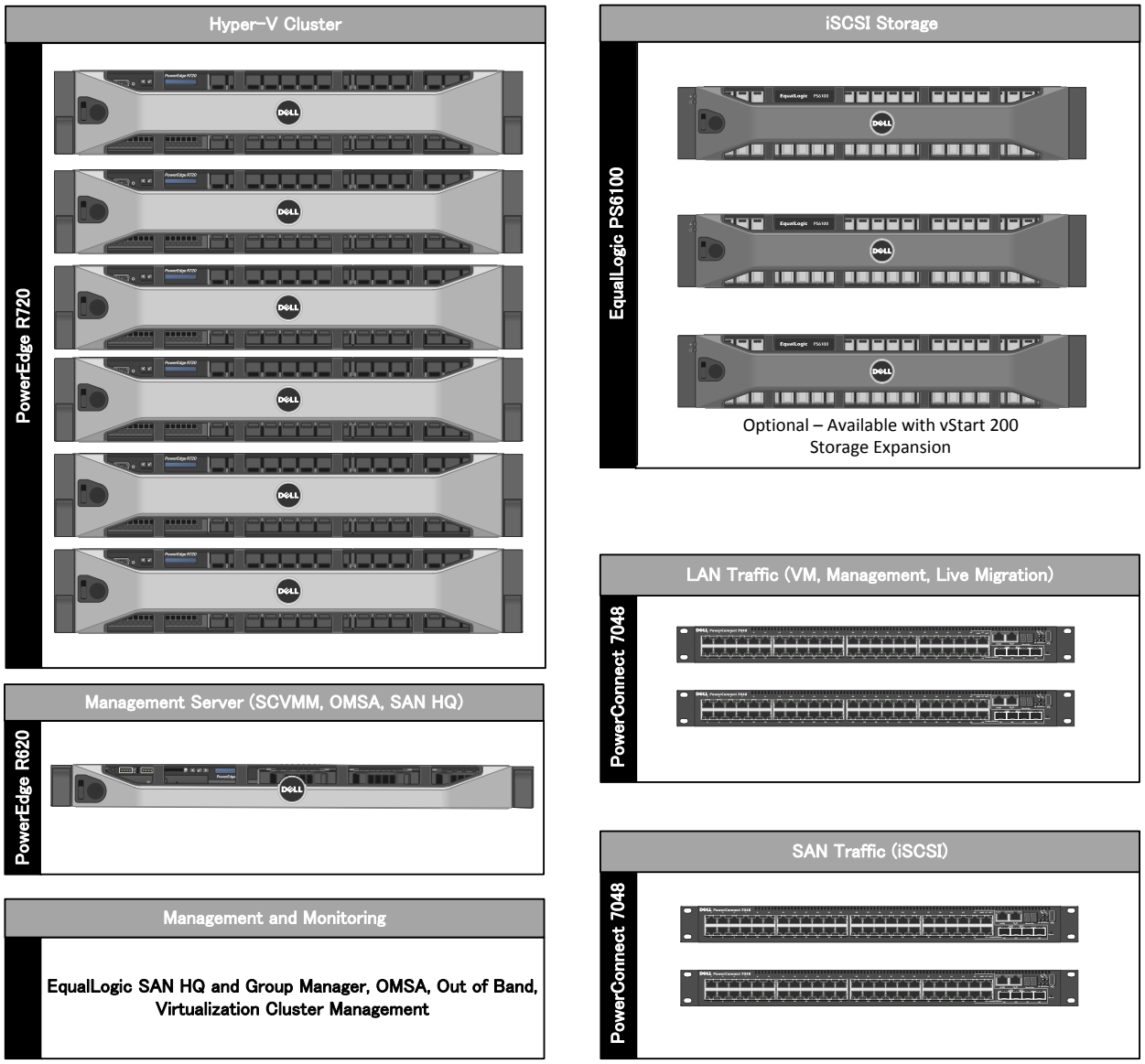


Table 1 below describes the solution components:

Table 1. Component Logical Groups

Component	Description	Role
Hyper-V Cluster	PowerEdge R720 servers running Windows Server 2008 R2 Datacenter Edition with SP1 and Hyper-V role enabled	Host virtual machines (VMs)
iSCSI Storage	EqualLogic PS6100X with 24 x 600 Gigabyte (GB) 10,000 RPM SAS Drives	Provide shared storage for the Hyper-V cluster to host the VMs
Management Server	PowerEdge R620 server running Microsoft ® Windows Server ®2008 R2 Standard Edition with SP1	Host optional SCVMM 2008 R2, and EqualLogic SAN HQ
LAN Traffic Switches	PowerConnect 7048 or 6248 switches	Support VM, Live Migration, Management, Cluster and Out-of-Band Management traffic
SAN Traffic Switches	PowerConnect 7048 or 6248 switches	Support iSCSI data

3.1 Product Overview

This section provides an overview of the components in the solution.

3.1.1 PowerEdge R720 for Hyper-V Cluster

The Dell PowerEdge R720 uses Intel® Xeon® E5-2600 series processors and Intel chipset architecture in a 2U rack mount form factor. The R720 is a powerful general purpose platform with highly expandable memory and I/O capabilities to match. Its extensive scalability and balanced design, allows it to handle very demanding workloads. The server features two CPU sockets and 24 memory slots supporting 2, 4, 8, 16, or 32GB DIMMs to meet the memory demands of a virtualized infrastructure.

Energy-efficient design features include power-supply units sized appropriately for system requirements, innovative system-level design efficiency, policy-driven power and thermal management, and highly efficient standards-based Energy Smart components. For more information, see the *PowerEdge R720 Technical Guide*.

3.1.2 EqualLogic PS6100 for iSCSI Storage

The Dell EqualLogic PS6100 is a virtualized iSCSI SAN that combines intelligence and automation with fault tolerance to provide simplified administration, rapid deployment, enterprise performance and reliability, and seamless scalability. The storage architecture delivers a self-optimizing SAN that is simple to manage and has an all-inclusive software suite to help reduce Total Cost of Ownership (TCO). In the vStart 100 and 200, the PS6100X uses 10,000 RPM Serial Attached SCSI (SAS) 2.5” form factor disk drives to provide capacity and performance for a range of applications.

With a 24 drive chassis full of 600GB SAS drives, the PS6100X array delivers 14.4 Terabyte (TB) of iSCSI-based storage built on fully-redundant, hot-swappable enterprise hardware. Scale out capacity and performance is provided by adding additional arrays. Built-in software functionality includes automated load balancing, snapshots and replication, multi-path I/O (MPIO), and consistency sets. SAN HQ is also available for Multi-SAN historical performance monitoring.

Advanced data protection features such as Auto Replication and Auto-Snapshot Manager (ASM) also come standard. ASM Microsoft Edition provides intelligent and consistent snapshots for the Windows Server 2008 R2 SP1 hosts and the Hyper-V environment.

Multipath IO (MPIO) capabilities are enhanced by the EqualLogic HIT KIT. The HIT Kit configures MPIO load balancing and redundant iSCSI initiator configurations for Windows Server-based hypervisor hosts. For more information about the HIT Kit for Windows Servers, see *Dell EqualLogic Host Software*.

3.1.3 PowerEdge R620 Management Server

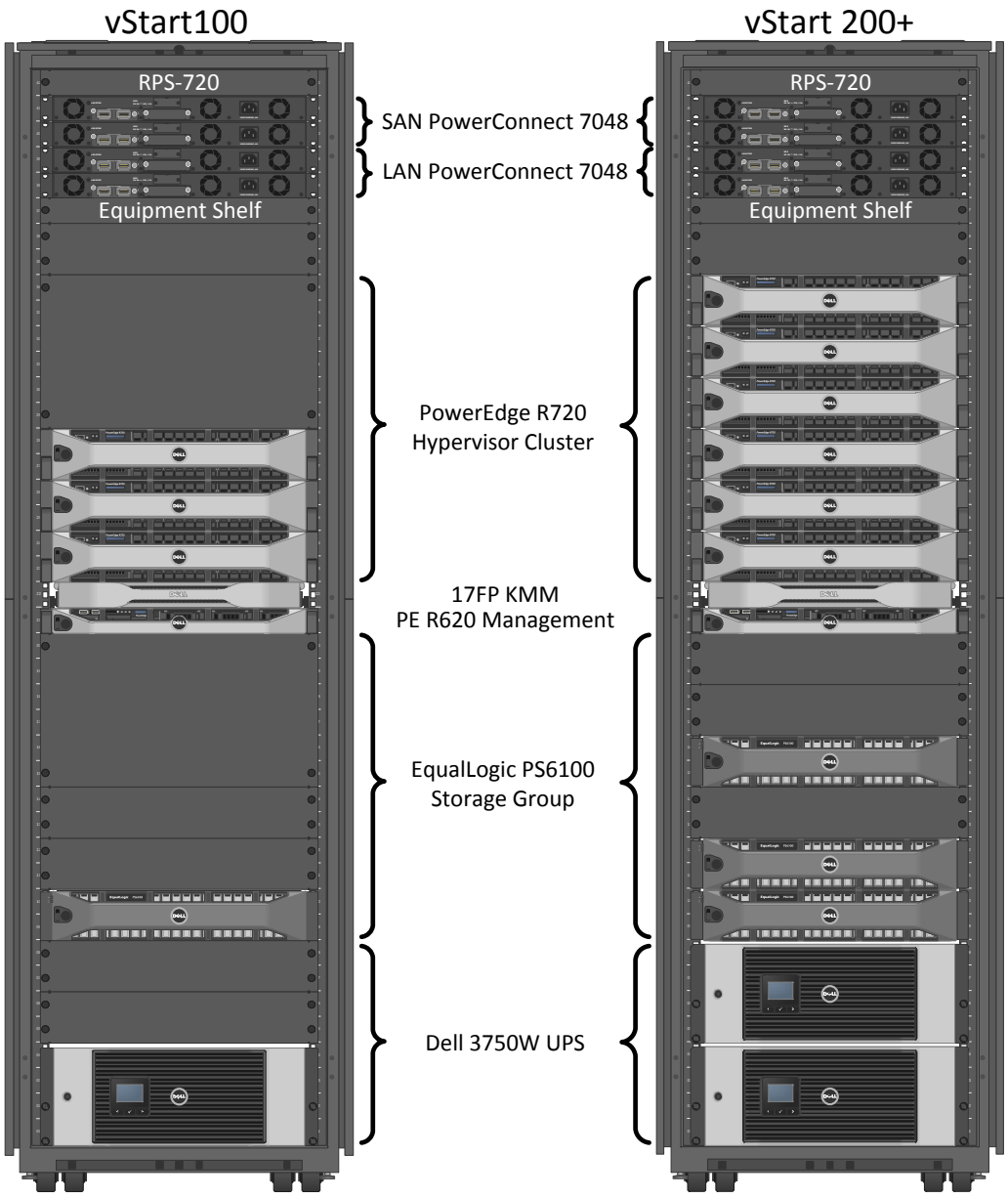
The Dell PowerEdge R620 uses Intel Xeon E5-2600 series processors and Intel chipset architecture in a 1U rack mount form factor. These servers support up to ten 2.5" drives and provide the option for an LCD located in the front of the server for system health monitoring, alerting, and basic management configuration. An AC power meter and ambient temperature thermometer are built into the server, which can be monitored on this display without any software tools. The server features two CPU sockets and 24 memory DIMM slots supporting 2, 4, 8, 16 or 32GB DIMMs.

Energy-efficient design features include power-supply units sized appropriately for system requirements, innovative system-level design efficiency, policy-driven power and thermal management, and highly efficient standards-based Energy Smart components. For more information, see the *PowerEdge R620 Technical Guide*.

3.1.4 PowerConnect 7048 or 6248 for LAN and SAN Traffic

At the heart of the solutions network configuration are four Dell PowerConnect 7048 or 6248 switches. These managed Layer 3 Gigabit Ethernet switches offer the enterprise-class level of performance required for this configuration. The LAN switches use a stacked configuration that enables connection redundancy and added bandwidth where required. Additionally, the 10Gb uplink enables design and implementation flexibility needed by advanced users. LAN and SAN switches are physically and logically separated per best practices to support security and network traffic segmentation. VLANs are implemented to support solution management, security, and network traffic segmentation, and routing is leveraged to provide flexible connectivity.

Figure 3. vStart 100 and 200 Component Overview



Note: The vStart design can accommodate a single PS6100 chassis with 24x 3.5" hard drives. In vStart 100+, 200, or 200+ configurations, the second array can be ordered in either the 2.5" or 3.5" version of the PS6100 chassis. There is an extra 2U of rack space open so that the factory can install and cable the larger 3.5" drive 4U array. The default PS6100X with 24x 2.5" hard drives requires only 2U of rack space, which is indicated in all of the diagrams in this document.

4 Design Principles

This section covers the design principles, requirements, and solution capabilities incorporated in the vStart solution architecture.

4.1 No Single Point of Failure

The solution is designed so that there is no single point of failure and redundancy is incorporated into all mission critical components of the solution. Management applications are not architected with this level of redundancy because the mission critical workloads will continue to operate in the event of a management application failure. Network redundancy for the mission critical components is achieved with redundant network interface controllers (NICs) and redundant switches. NIC teaming for LAN and MPIO for SAN are used to provide failover across the redundant network interfaces.

For iSCSI storage, redundancy is achieved with redundant NICs, switches, and storage controllers. For both network and iSCSI traffic, the redundant NICs are selected in such a way that they are mapped across the rack Network Daughter Card (rNDC) and add-in controllers to avoid any single point of failure. Hyper-V High Availability (HA) is provided by Windows Server 2008 R2 Failover Clustering. The solution also includes redundant power supplies connected to separate PDUs.

4.2 Physical Separation of LAN and iSCSI SAN Traffic

Dedicated NICs and switches are provided for iSCSI storage traffic to isolate the storage traffic from LAN traffic. This helps to minimize network latency for storage I/O operations.

4.3 Logical Separation of multiple LAN traffic types

Virtual Local Area Networks (VLANs) are used to provide security and logical separation of various traffic types required for virtualization.

4.4 Prerequisites and Datacenter Planning

To support either of the configurations, the following components are required to be present in the customer environment:

- Active Directory® (AD) Domain Services (AD DS) – An AD DS domain must be available on the network. The Hyper-V hosts will be joined to an existing or new domain. Cluster Services also require AD DS. Optional management solutions like SCVMM require AD DS; however, this aspect is out of scope for this paper. Consult with your Dell Sales and Services representatives for more details.
- Domain Name Server (DNS) – DNS must be available on the management network.
- Network Time Protocol (NTP) Server - NTP is recommended on the management network.
- Sufficient power to support a vStart 100 or 200 must be present. Detailed power, weight, and cooling requirements for the datacenter are defined in the *vStart 100 and 200 Hyper-V Solution Specifications* document.
- Switch Connectivity – The network architecture supports uplinks into the existing switches in the datacenter. The uplink recommendations are discussed in Section 5.1, Network Architecture.

- Optional) Database to support SCVMM - For a list of supported databases refer to the *SCVMM Database Systems Requirements*, or the Operations Manager 2007 R2 Supported Configurations.
    - If IT Administrators wish to install SCVMM on the R620 Management Server or as a VM, then a route must exist between the Management Server (physical or as a VM) and the database for SCVMM.
    - The database is assumed to have maintenance and backup configured as per the business needs of the customer.

5 Architecture

The architecture discussed in this section will focus on the vStart 100 and the vStart 200 solutions.

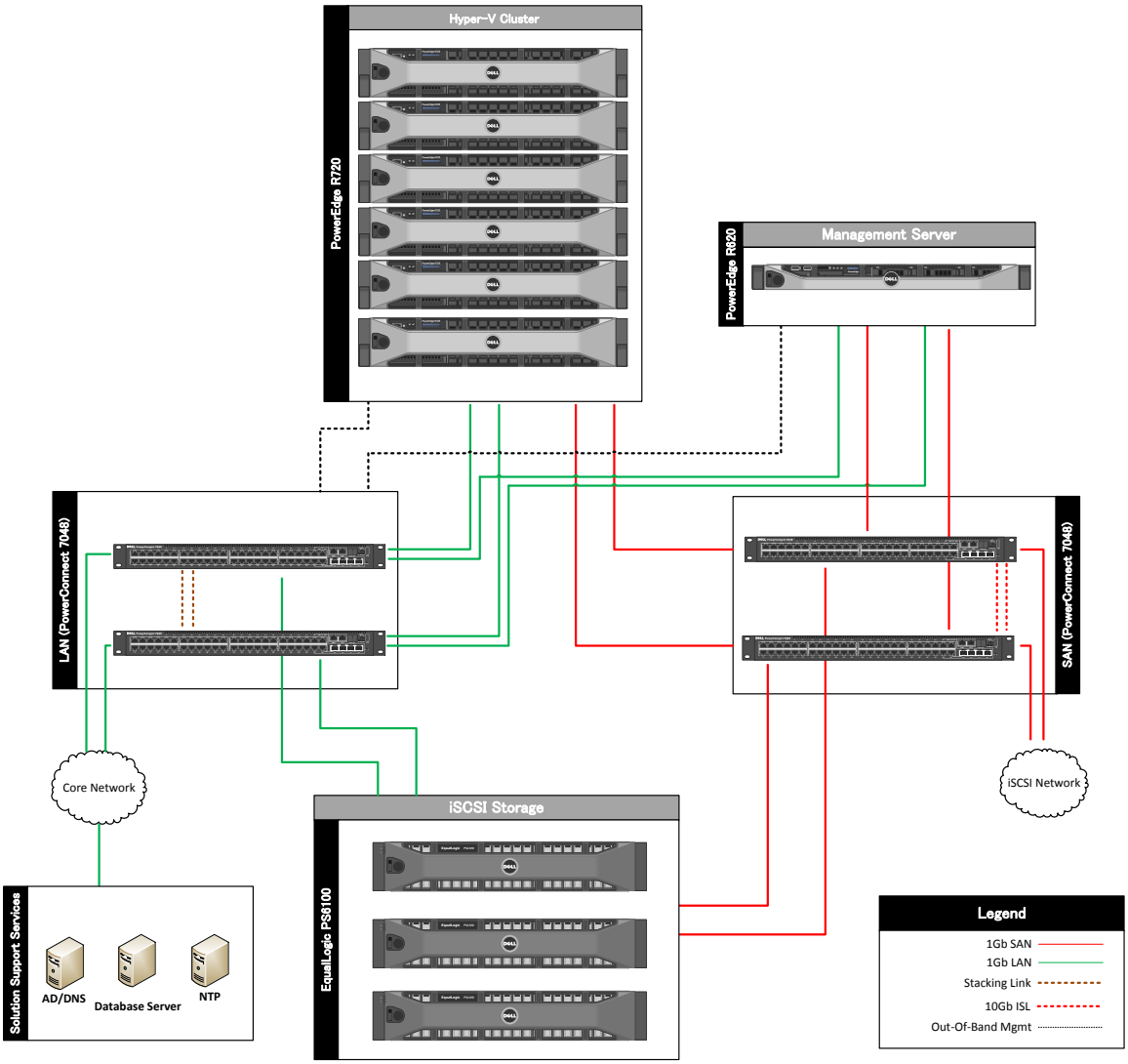
5.1 Network Architecture Overview

Hyper-V network traffic in this solution is comprised of five distinct types: Virtual Machine (VM), Management, Live Migration, Cluster Private, and iSCSI. In addition, support for Out-of-Band Management (OOB) is included. Two separate networks are created to support different traffic types:

- **LAN** - This network supports management, VM, Live Migration, Cluster Private, and out-of-band management. In addition, uplinks to core infrastructure provide connectivity to the solution support services (AD, DNS, NTP, and database for management applications).
- **SAN** – This network supports iSCSI data. Uplinks are supported to connect into an existing iSCSI network; however, these uplinks are not required for full solution functionality. SAN switch out-of-band management also occurs on this network.

Figure 4 shown below depicts the vStart 200 logical LAN and SAN network architecture.

Figure 4. vStart 200 Network Topology (Logical View)



The table below summarizes the use of each traffic type.

Table 2. Traffic Type Summary

Traffic Type	Use
Management	Supports virtualization management traffic and communication between the Hyper-V R2 servers in the cluster
Live Migration	Supports migration of VMs between Hyper-V Host servers in the cluster
VM	Supports communication between the VMs hosted on the cluster and external systems
Cluster Private	Supports internal cluster network communication between the servers in the cluster
Out-of-Band Management	Supports configuration and monitoring of the servers through the iDRAC management interface, storage arrays, and network switches
iSCSI Data	Supports iSCSI traffic between the servers and storage array(s). In addition, traffic between the arrays is supported

5.2 LAN Architecture

The LAN includes two PowerConnect 7048 or 6248 switches which support VM, Management, Cluster Private, Live Migration, and OOB traffic. These traffic types are logically separated through the use of VLANs. The two switches are stacked together, which forms a single logical switch and provides a 48Gb link between the two PC6248 switches, or 64Gb between the two PC7048 switches. The solution provides four 1Gb uplinks from each switch to link into an existing core network infrastructure. If the core network infrastructure supports 10Gb Ethernet, then 10Gb uplink modules may be added to each switch; however this option is beyond the scope of this document.

5.2.1 Traffic Isolation using VLANs

The traffic on the LAN is segregated into five VLANs; one VLAN each for, VM, Management, Live Migration, Cluster Private, and OOB traffic. VLAN tagging is performed through switch tagging as well as host level tagging.

5.3 SAN Architecture

The SAN includes two PowerConnect 7048 or 6248 switches which support iSCSI data traffic. The two switches are connected together with stacking modules in Ethernet mode configured as an inter-switch link (ISL) Link Aggregation Group (LAG). In addition, the solution supports up to eight 1Gb uplinks from each switch to link into an existing core iSCSI network infrastructure. These uplinks are optional. If required, 10Gb uplink modules may be added to each switch; however these options are beyond the scope of this document.

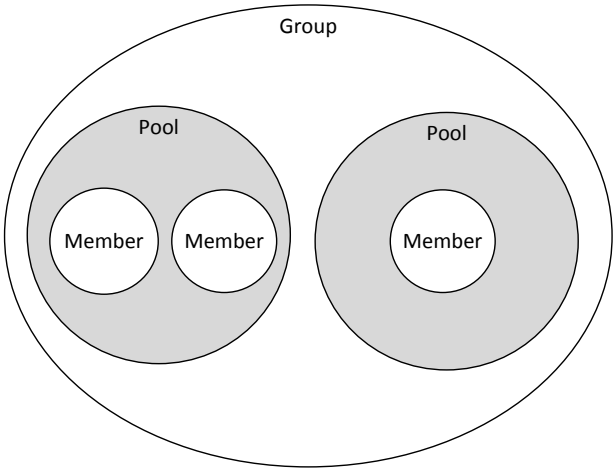
5.3.1 Traffic Isolation using VLAN

The traffic for the SAN is also segregated into its own VLAN. This facilitates isolation from the default VLAN and gives a separation between SAN traffic and any other traffic that it may come across if the SAN is uplinked to a LAN or extended to another SAN for replication.

5.3.2 EqualLogic Storage Concepts

Each EqualLogic array (or member) is assigned to a particular group. Groups help in simplifying management by enabling management of all members in a group from a single interface. Each group contains one or more storage pools. Each pool must contain one or more members and each member is associated with only one storage pool. Figure 5 shows an example of a group with three members distributed across two pools.

Figure 5. EqualLogic Organizational Concepts



The iSCSI volumes are created at the pool level. In the case where multiple members are placed in a single pool, the data is distributed amongst the members of the pool. With data being distributed over a larger number of disks, the potential performance of iSCSI volumes within the pool is increased with each member added.

For more information, consult with your Dell Sales and Services representatives for planning out and designing an EqualLogic storage solution. Also, refer to the white paper, *Using Tiered Storage in a PS Series SAN*, available at http://www.equallogic.com/WorkArea/DownloadAsset.aspx?id=5239.

5.3.3 Volume Size Considerations

Volumes are created in the storage pools. Volume sizes depend on the customer environment and the type of workloads. Volumes must be sized to accommodate not only the VM virtual hard drive, but also

the size of the virtual memory of the VM and additional capacity for any snapshots of the VM. Depending on the environment, one may decide to create multiple ~500 GB volumes with multiple VMs.

It is important to include space for the guest operating system memory cache, snapshots, and VM configuration files when sizing these volumes. Additionally, one can configure thin-provisioned volumes to grow on demand only when additional storage is needed for those volumes. Thin provisioning can increase the efficiency of storage utilization.

With each volume created and presented to the servers, additional iSCSI sessions are initiated. When planning the solution, it is important to understand that group and pool limits exist for the number of simultaneous iSCSI sessions. For more information, refer to the current EqualLogic Firmware (FW) Release Notes. FW Release Notes are available at the EqualLogic Support site https://support.equallogic.com/secure/login.aspx.

5.3.4 Storage Array RAID Considerations

The storage array RAID configuration is highly dependent on the workload in your virtual environment. The EqualLogic PS series storage arrays support four RAID types: RAID 5, RAID 6, RAID 10, and RAID 50. The RAID configuration will depend on workloads and customer requirements. In general, RAID 10 provides the best performance at the expense of storage capacity.

RAID 10 generally provides better performance in random I/O situations, and requires additional overhead in the case of a drive failure scenario. RAID 50 generally provides more usable storage, but has less performance than RAID 10. RAID 5 provides the most storage capacity at the expense of lower performance and availability than RAID 10. RAID 6 provides better data protection than RAID 5 or 50.

For more information on configuring RAID in EqualLogic, refer to the white paper, *How to Select the Correct RAID for an EqualLogic SAN*, available at http://www.EqualLogic.com/resourcecenter/assetview.aspx?id=8071.

5.4 Hyper-V Role and Failover Clustering Design

5.4.1 Roles and Features

The Hyper-V role is required on the Windows Server 2008 R2 Datacenter host. The role enables features such as creation, starting, and stopping of VM.

Failover Clustering is a feature that, when combined with the Hyper-V role provides fault tolerance at the server level and enables features like Live Migration and VM failover.

More information on setting up Failover Clusters for Hyper-V can be found on Microsoft TechNet in *Hyper-V: Using Hyper-V and Failover Clustering* available at http://technet.microsoft.com/en-us/library/cc732181(WS.10).aspx .

Cluster Shared Volumes (CSV) is implemented on the Hyper-V cluster to allow multiple virtual machines to utilize the same volume and migrate to any host in the cluster. The Live Migration feature of Windows Server 2008 R2 allows movement of a virtual machine from one host to another without perceivable downtime. For more information on configuring CSV and the network for live migration see *Hyper-V: Using Live Migration with Cluster Shared Volumes in Windows Server 2008 R2 available at:*

http://technet.microsoft.com/en-us/library/dd446679(WS.10).aspx

5.5 Management Architecture

The management architecture of the vStart configurations includes hardware and software components that will manage all components of the vStart architecture. They can be found on the R620 server or on VMs running on the R620.

5.5.1 Management on the LAN

The management traffic on the LAN includes:

- Out-of-band server management through the iDRAC7 Enterprise
- Server management through Dell OpenManage Server Administrator
- Hyper-V and Cluster Manager
- LAN switch management through CLI or web browser
- EqualLogic array management through CLI or web browser
- EqualLogic array monitoring with SAN HQ
- Virtualization Management with SCVMM

Server Out-of-Band Management: The PowerEdge R720 servers and the PowerEdge R620 can be managed directly by connecting to the iDRAC7 SSH or web interface. In addition, the iDRAC7 supports remote KVM through a virtual console.

Dell OpenManage Server Administrator (OMSA): OMSA provides server hardware data to the host. Information presented includes fan speeds, operating temperature, and various other heath monitors. For more information about OMSA, refer to the Dell TechCenter at http://www.delltechcenter.com/page/OpenManage+Server+Administrator+-+OMSA .

Hyper-V Cluster Management: Management of the Hyper-V hosts may optionally be performed directly with SCVMM 2008 R2, but can also be performed by connecting to each server through the

Hyper-V Manager that can be run from the R620 Management Server or VM. Server Manager can also be utilized to access Hyper-V Manager, while the cluster is managed from the Failover Cluster Manager.

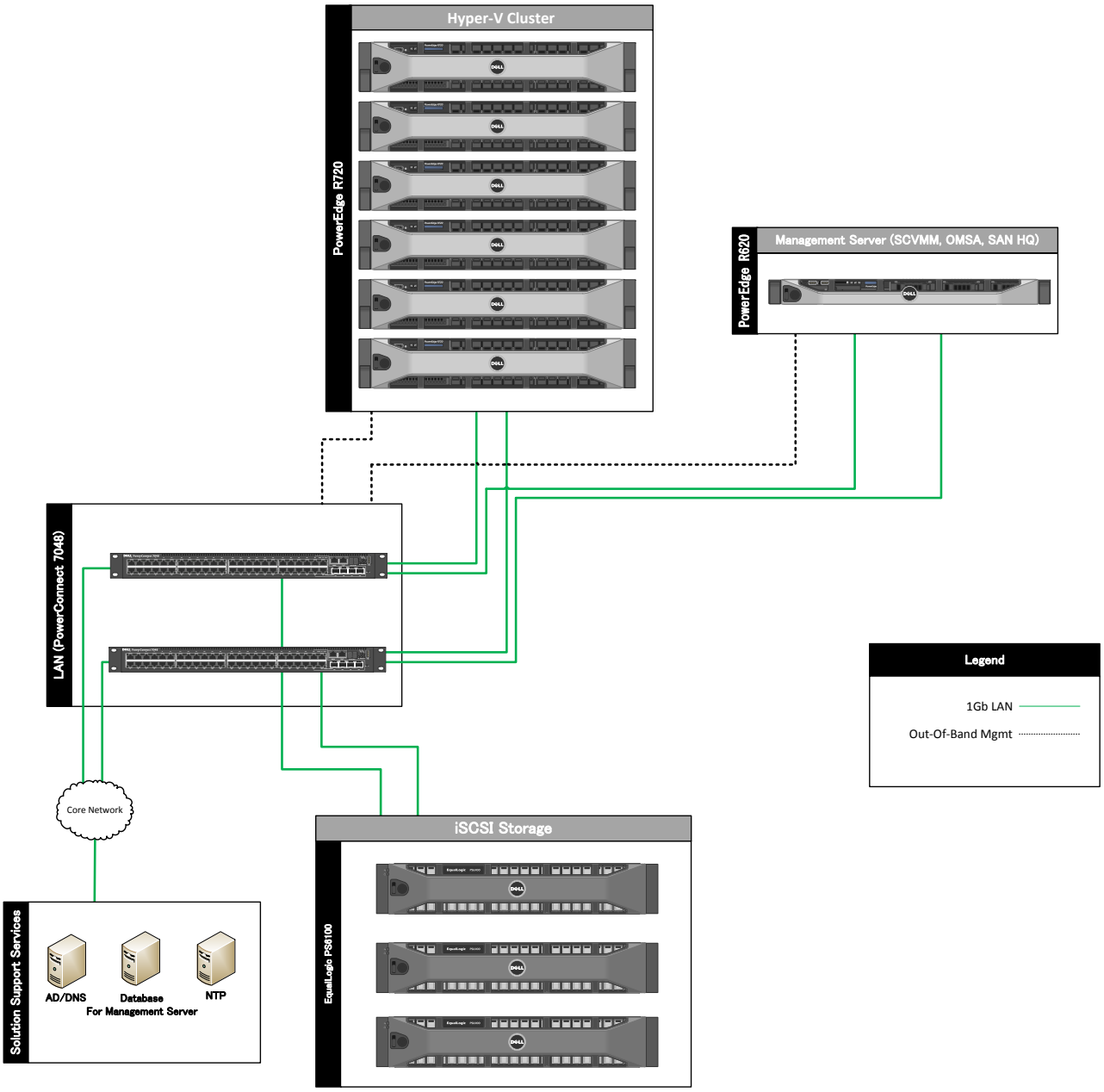
LAN and SAN Switch Management: Management of the LAN and SAN switches can be performed through a web browser, serial cable, or telnet.

EqualLogic Array Management: The EqualLogic arrays are managed through the EqualLogic Group Manager Web interface or through the SSH console, which can be accessed from the management server. Administrator primary tasks within Group Manager include configuration and troubleshooting of the arrays.

EqualLogic Array Monitoring: SAN HQ is installed on the management server to provide current performance monitoring and historical statistics. Group Manager can also be used for array monitoring.

A logical overview of the LAN management architecture is shown in Figure 6. Notice that the PS6100 arrays are managed via the dedicated management ports that are connected to the LAN switches.

Figure 6. Management Overview (LAN)



6 Scalability

When adding additional servers or storage to the rack, power, rack space, weight, and cooling requirements must be taken into account. The power limits of PDUs and UPSs must be understood prior to installing a new system.

Switch ports on both the LAN and SAN switches are available for expansion. Those ports must be enabled and configured to support the new servers and/or storage arrays.

6.1 Adding new servers to the Hyper-V Cluster

If additional VMs will be deployed that will exceed current resource capabilities, or the Hyper-V cluster has reached its acceptable maximum (CPU and memory) resource utilization, then additional servers can be added to the cluster up to a maximum of 16 nodes depending on the rack and datacenter capacity. See the *Limitations for using Hyper-V and Failover Clustering* section for more information at this link http://technet.microsoft.com/en-us/library/cc732181(WS.10).aspx

Previously created iSCSI volumes on the EqualLogic array may require modifications to the access controls to grant access to the newly added servers.

When adding servers to a Hyper-V cluster, it is recommended that the configuration be identical to the other systems in the cluster. If this is not achievable, there may be restrictions on certain actions, such as Live Migration between the differing systems. To understand Live Migration compatibility requirements, refer to the Microsoft whitepaper, *Windows Server 2008 R2 Hyper-V Live Migration Overview and Architecture*, available at http://www.microsoft.com/download/en/details.aspx?id=12601.

6.2 Adding new storage to the EqualLogic group

New EqualLogic arrays can be added to the existing EqualLogic group. As each new array is added to the storage group, the storage capacity and performance, in terms of both bandwidth and IOPS, are increased. This increased capacity can be utilized without downtime. When a new array is added to an existing pool, the existing data will automatically be distributed to the newly added array.

If EqualLogic thin provisioning was utilized and virtual capacity allocated is nearing the limit of physical capacity, adding an additional storage array to the constrained pool will address this issue. The impact to the total iSCSI session count for the EqualLogic group and pools must be also be understood when adding either new servers or EqualLogic arrays.

7 References

Microsoft references:

- Windows Server 2008 R2 Datacenter
  http://www.microsoft.com/en-us/server-cloud/windows-server/2008-r2-datacenter.aspx

- Install the Hyper-V Role on a Full Installation of Windows Server 2008 R2
  http://social.technet.microsoft.com/wiki/contents/articles/steps-to-install-hyper-v-role-on-server-2008r2.aspx

- Failover Clusters in Windows Server 2008 R2
  http://technet.microsoft.com/en-us/library/ff182326(WS.10).aspx

EqualLogic references:

- Dell EqualLogic PS Series Architecture Whitepaper
  http://www.dell.com/downloads/global/products/pvaul/en/dell_equallogic_architecture.pdf

  Host Integration Tools for Windows
  http://www.dell.com/downloads/global/products/pvaul/en/equallogic-host-software.pdf

- How to Select the Correct RAID for an EqualLogic SAN
  http://www.equallogic.com/resourcecenter/assetview.aspx?id=8071

- Using Tiered Storage in a PS Series SAN
  http://www.equallogic.com/resourcecenter/assetview.aspx?id=5239

- Monitoring your PS Series SAN with SAN HQ
  http://www.equallogic.com/resourcecenter/assetview.aspx?id=8749